Role of dietary fibre in rabbit nutrition and digestive troubles prevention

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Dietary fibre origin

Fibre Sources?
Origin of the different types of fibre

**Standard Plant Cell**

**Plant Cell Walls**

**Fibre Source**

**Plant cell wall layers:**
- Middle Lamella
- Primary Wall
- Secondary Wall
MIDDLE LAMELLA

is a flexible pectic region that fill gap between two adjacent cells. It may content lignin

PRIMARY CELL WALL

consist of cellulose macrofibrils, extremely strong. The macrofibrils are complexed with hemicellulose, hydrogen bounded to adjacent cellulose fibrils

Primary cell wall contents also pectins and small quantities of glycoproteins and lignins
Schematic representation of the primary cell wall
MIDDLE LAMELLA

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SECONDARY CELL WALL

Main advantage is increased strength
From INSIDE primary wall, between cell membrane and primary wall. Contains NO PECTIN, but mainly cellulose and usually lignin
Cytoplasm

Storage carbohydrates, lipids, proteins, etc

Secondary wall

Primary wall

Middle lamella

PECTINS

HEMICELLULOSE

CELLULOSE

LIGNINS
Total Dietary Fibre

- Polyphenol
- Lignins
  - Cellulose
  - Hemicelluloses
  - Pectic Substances
- Non Starch Polysaccharides = NSP
- Water-Soluble NSP (water solub. Pectins, β-glucans, arabinoxylans, …)

Water Insoluble Cell Wall
CHEMICAL COMPOSITION
OF DIETARY FIBRE COMPONENTS

**Lignins**: non saccharide polymer. Built up from 3 phenyl-propane units (conferilic, coumarilic & sinapilic acids) very branched and complex network Resistant to most chemical and enzymatic agents, those of bacteria included

**Cellulose**: the major structural polysaccharide. Homopolymer formed from linear chains of β (1-4) linked D-glucose units (starch is is a polymer of the same units but α (1-4) linked). Degree of polymerization is usually 8 000 to 10 000. Soluble only in strong acid solutions.
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**Hemicelluloses**: a group of several polysaccharides with lower degree of polymerization than cellulose. A β (1-4) linked backbone of xylose, mannose, arabinose or glucose units. Generally branched heteropolymers, units linked in β 1-3, β 1-6, α 1-4, α 1-3, …)

**Pectins**: are composed of a polygalacturonic linear chain backbone always branched with neutral sugars (mainly arabinose and galactose). From place to place the linear chain includes L-rahmnose unit.
MAIN GRAVIMETRIC METHODS FOR DETERMINATION
OF DIETARY FIBRE IN ANIMAL FEEDS

Carré & Brillouet (1989)
Weende (1859)

Class of Polymer
Lignins
Cellulose
Hemicellulososes
Pectic Subst. (insoluble)

ADL
Crude Fibre

WICW
Water
Insoluble Cell Wall

NDF
ADF

Polymer Class
Lignins
Cellulose
Hemicellulososes
Pectic Subst. (insoluble)
### Apparent DIGESTIBILITY of the different types of fibre in the Rabbit

<table>
<thead>
<tr>
<th>Class of dietary fibre</th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lignins (ADL)</td>
<td>10 - 15</td>
<td>-13 to +50</td>
</tr>
<tr>
<td>Cellulose (ADF - ADL)</td>
<td>15 - 18</td>
<td>5 to 40</td>
</tr>
<tr>
<td>Hemicellulose (NDF - ADF)</td>
<td>25 - 35</td>
<td>10 to 60</td>
</tr>
<tr>
<td>Pectins (total uronic acids)</td>
<td>70 - 76</td>
<td>30 to 85</td>
</tr>
</tbody>
</table>
GENERAL SITUATION

- Dietary Fibre Level
- Diet's digestibility
- Feed efficiency
- Feeding cost
For the "nutritionist", any reduction of diet's fibre level will induce a reduction of nutritional costs. Thus for him, it's clear and simple.

**THE BEST FIBRE LEVEL IS ALWAYS THE LOWEST**

**BUT** "breeders" and "pathologists" have observed that low dietary fibre levels are frequently associated with digestive troubles and very often mortality.
As a consequence : 2 questions

1. How to measure the sanitary risk?

2. Which type of fibre is efficient to reduce the risk and if defined, at which level?
Digestive Health Status Estimation in the Rabbit
MORBIDITY = very low growth rate or weight loss
and/or transitory diarrhea
and/or intake trouble (sudden decrease, ...)

MORTALITY

22%

For rabbits alive at the end of the period

Example of health trouble with a fibre deficient diet (Bennegadi et al. 2000)
Example of Sanitary Risk with a fibre deficient diet (Bennegadi et al. 2000)
SR = period 28-70d. of age (> 40 rabbits / diet, one point = one diet)
(Gidenne et Jehl, 1999; Pinheiro et Gidenne, 1999; Gidenne et al., 1998).

Sanitary Risk%

% Lignocellulose “ADF”

Correlation = ?

ADF alone is not sufficient to define fibre requirement

Is ADF a sufficient criterion or not?
Sanitary risk and diet’s ADL level

Recommendation: a minimum of 5% of lignin
but attention ADL is not = true lignin in some cases
Effect of proportion of lignin in the ADF

ADF = 16% (constant) ;  NDF = 30% (constant)  
Starch = 22% (constant)

(Gidenne et al. 2001a)
Sanitary risk and relative supply of digestible fibre “DgF” and of lignocellulose “ADF”.

Digestible fibre (DgF) = Hemicelluloses + insoluble Pectins

Sanitary Risk over 30% if the DgF/ADF ratio is over 1.3

\[ y = 4.44e^{1.4x} \]

\[ R^2 = 0.88 \]
Digestible Fibre vs Starch
(504 growing rabbits / diet - 6 experimental sites)

Mortality (%)

Proportion of STARCH

ADF = 18% ; ADL= 4.3% ; WICW + Starch = ~constant 52%

Growth rate = 42.5 g/d whatever starch proportion
### Recommendations for growing rabbits

*(as fed basis)*

<table>
<thead>
<tr>
<th></th>
<th>Weaning =&gt; 45 d</th>
<th>End of fattening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lignocellulose &quot;ADF&quot; (%)</td>
<td>19 = 17</td>
<td></td>
</tr>
<tr>
<td>Lignins &quot;ADL&quot; (%)</td>
<td>5.5 = 5.0</td>
<td></td>
</tr>
<tr>
<td>Cellulose (ADF-ADL) (%)</td>
<td>13 = 11</td>
<td></td>
</tr>
<tr>
<td>Ratio lignins/cellulose</td>
<td>&gt; 0.4 &gt; 0.4</td>
<td></td>
</tr>
<tr>
<td>Hemicelluloses (NDF-ADF) (%)</td>
<td>&gt; 12 &gt; 10</td>
<td></td>
</tr>
<tr>
<td>Ratio Digest Fibre/ ADF</td>
<td>1.3 = 1.3</td>
<td></td>
</tr>
<tr>
<td>Starch</td>
<td>&lt; 13 &lt; 18</td>
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Thanks for your attention